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Gender difference in path dependency and spousal bargaining in lifestyle formation: Evidence from Korea

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Abstract

We investigate a direct spousal influence on individual risky behavior such as sedentariness, smoking and drinking. We also assess its economic importance relative to that of an individual's own path dependency, and we compare the results between women and men. Using the longitudinal data from the Korean Labor & Income Panel Study (KLIPS) from 2005 to 2014, we apply a bivariate dynamic probit model with random effects to control for individual unobserved heterogeneity and contemporaneous shocks that are shared between partners. While prior studies reveal that the spousal spillover effect is muted once assortative mating and shared environment are considered, our results demonstrate that intra-household bargaining still plays a role. We also find that both females and males receive an equivalent magnitude of peer pressure from their spouses regarding sedentariness and drinking. Social learning or altruism explains females' behavior better, whilst path dependency is more pronounced among males. Our findings suggest that healthy lifestyle can be effectively promoted if policies target male populations, considering their stronger addictive tendency. Nonetheless, due to the modest magnitude of spousal peer effect and path dependency, the impact of such an intervention would be limited.

Keywords: spousal effect, lifestyle, dynamic bivariate probit, random effect

1 Introduction

Married couples tend to converge in terms of lifestyle (e.g. Tambs and Moum, 1992; Clark and Etilé, 2006; Falba and Sindelar, 2008; Canta and Dubois, 2015) as well as health outcomes (e.g. Silventoinen et al., 2003; Kim et al. 2006). The sources of spousal resemblance are diverse, having various policy implications. First, through daily interaction, people are directly influenced by their partner's behavior. The direct interaction involves several channels that are not mutually exclusive (Khwaja et al., 2006; Mcgeary, 2015). That is, people may adjust their behavior through bargaining and/or be motivated to do so by consumption externalities, social learning and altruism. A number of studies demonstrate each mechanism empirically. For instance, based on the Health and Retirement Study (HRS) from the U.S., Khwaja et al. (2006) reveal that having a spouse reduces individual livelihood of smoking, which suggests consumption externalities. Using the same data, Mcgeary (2015) shows that spousal smoking cessation plays a significant role in individual decision to quit smoking, which supports bargaining. The author also reports that people are more likely to quit smoking when their spousal health declines, which implies social learning or altruism. Canta and Dubois (2015) explain that social learning can also encourage a couple's joint participation in smoking if one learns form her/his smoking partner that smoking is not too harmful.

Second, it is also possible that a behavioral change is induced by an exogenous shock that simultaneously affects both partners. Cohen-Cole and Fletcher (2008) demonstrate the importance of this mechanism, namely a contextual effect, regarding the peer effect on an adolescent's obesity. They revisit Fowler and Christakis (2008)'s investigation on the same subject and report that the peer effect becomes insignificant once shared environment and individual fixed effects are controlled. Lastly, assortative mating in the marriage market is another underlying factor. Prior studies suggest that people are more attracted to potential partners who have similar backgrounds (i.e. social homogamy) or other characteristics (i.e. assortative mating) that are correlated with future lifestyle (e.g. Sutton, 1993; Houts, Robins, and Huston, 1996; Silventoinen et al., 2003).

The aim of this study is to test the presence of a direct spousal contribution to individual decisions on a series of risky behavior such as sedentariness, smoking and drinking. As Palali and Ours (2015) argue, if a spouse plays a role in changing lifestyle, a public policy for promoting healthy lifestyle would then have greater impact due to the idea of reaching "two for the price of one". Moreover, we attempt to assess its economic importance relative to that of an individual's own path dependency, and we compare the results between women and men. We identify the path dependency by including individual lagged behavior in our model.

Its coefficient represents the intensity of addiction in risky behavior and will also indicate a direct gain from public intervention that leads to individual behavioral change. Concerning gender differences, literature provides mixed results, which calls for further investigation. For instance, from American data, Umberson (1992) find that 80% of married men name their spouse as a primary control agent of health behavior, while only 59% of married women do so. On the other hand, from French data, Canta and Dubois (2015) find higher spousal peer pressure among women in terms of smoking. In a nutshell, our investigation helps gauge both direct and spillover effects of a potential policy and helps propose a more suitable target for effective intervention.

We also consider other mechanisms in our estimation. Following Clark and Etilé (2006), we apply a bivariate dynamic probit model with random effects to control and quantify correlated unobserved heterogeneity (i.e. assortative mating) and common shocks between partners. Our model also includes deterioration of both an individual's as well as their spouse's health as covariates to demonstrate a mechanism of social learning or altruism. In addition, by adopting Kano (2008)'s strategy, we quantify population-average partial effects of major regressors in the short and long term.

While prior investigations are mostly based on Western societies (See literature review in Section 2), we focus on the case of South Korea in order to open up a discussion on spousal interaction under a different institutional and cultural setting. Korean society has several distinctive features pertaining to marriage and lifestyle (See Section 3), which may alter the nature of intra-household interaction. Particularly, gender-specific social pressure on smoking and drinking behavior gives us further motivation to compare gender differences in spousal role.

As expected, we obtain some deviating results. Contrary to Clark and Etilé (2006)'s findings from British data, for example, we observe a significant positive spousal role in most lifestyle choices even after controlling for other mechanisms. Exceptionally, females' decision on tobacco consumption seems to be independent of spousal behavior, presumably due to strong social negativism against their smoking. In addition, we find evidence of positive assortative mating with respect to sedentariness and drinking. Our results also suggest that a mechanism of social learning or altruism explains females' behavior better than males', which is consistent with Mcgeary (2015) and Canta and Dubois (2015)'s findings. Furthermore, path dependency is relatively more pronounced among males with respect to all types of lifestyle. Nevertheless, we do not find any substantial gender difference in terms of direct spousal effect regarding sedentariness and drinking. Our results imply that interventions regarding lifestyle can be more effectively implemented if the male population is targeted, considering their more severe addiction problem. However, the impact of such policies would be limited since the magnitude of both spousal effect and path dependency is modest.

2 Literature review

A major challenge in identifying a (direct) spousal role in lifestyle formation is to isolate the impact of time-variant or -invariant heterogeneity which might be shared between partners. Literature suggests various approaches that each have their own (dis)advantages. Some researchers exploit aggregated data. For example, Tambs and Moum (1992) group the data of 15,925 Norwegian couples by their marital duration, t, and regress the observed spousal correlations in each outcome on t. They attempt to capture the degree of convergence or divergence via a coefficient of t, assuming that longer spousal interaction would magnify the correlation. They also presume that premarital assortative mating is depicted by a constant term. The authors find moderate convergence in lifestyle (e.g. alcohol consumption, smoking, exercise and work stress) and divergence in terms of personality (e.g. Type A behavior and nervousness). By applying a similar method on 1,296 couples with children in Minnesota, Humbad et al. (2010) report that spousal congruence in personality traits is not reinforced over time, except for in the case of aggression.

This approach is especially useful when the data is collected from large cross-sectional surveys. Furthermore, one can easily explore the nonlinearity of the spousal effect though a flexible model specification with respect to t (e.g. log transformation). However, it does not allow for the incorporation of individual or household-specific confounding factors as additional regressors. Therefore, this strategy may not be suitable for our investigation which intends to use an individual's own past behavior as another major explanatory variable.

On the other hand, other studies employ individual-level panel data. Clark and Etilé (2006) take an innovative approach by adding bivariate specification to a dynamic probit estimation. Using British household data, they introduce both partners' smoking status as simultaneously determined outcomes. They estimate the equations of a wife and a husband's behavior jointly where spousal smoking serves as a main explanatory variable by enabling error terms to be correlated under a bivariate discrete distribution. Using a similar strategy but with a different assumption on correlated random effects (i.e. bivariate normal distribution), Kano (2008) delves into the issue of obesity in the U.S.. Both studies find an insignificant or limited role of spousal past behavior, suggesting greater importance of assortative mating and/or a common environment. Based on similar intuition, Palali and Ours (2015) jointly estimate mixed proportional hazard models of both spouses' time to quit smoking using Dutch household data. They report an insignificant direct effect of spousal quitting behavior, which implies the same message as earlier studies. Nevertheless, they find a significant negative effect of a spouse's continuous smoking on individual smoking cessation.

Among other existing approaches, we adopt Clark and Etilé (2006)'s strategy, which fits with our goal as well as data availability. One of the important advantages of their bivariate approach is that one can explicitly quantify a spousal correlation in unobserved heterogeneity (i.e. assortative mating) in addition to a direct spousal effect. In other words, this approach enables us to illustrate both direct and indirect mechanisms. If a researcher is solely interested in identifying the former, other conventional econometric techniques are also applicable. For instance, to demonstrate a causal effect of spousal behavior on individual smoking decision, Cutler and Glaeser (2010) use the presence of a workplace smoking ban as an instrumental variable (IV). Mcgeary (2015) uses a (univariate) fixed effect estimation to highlight direct spousal interaction regarding smoking cessation while controlling time-invariant individual heterogeneity.

A disadvantage is related to data requirements. Since the dynamic model with random effects necessitates panel data with relatively large T ($T \geqq 3$), it is unavoidable to exclude the couples with small T, such as the newly (re)married and dropouts, in the estimation. Consequently, the investigation is restricted to the case of medium or long term marriage. Ignoring the latter group might be problematic because the sample attrition due to separation or divorce can cause upward bias with respect to spousal effect. That is, this group may have been more reluctant to adjust lifestyles or prone to let it diverge from their former spouse's. Clark and Etilé (2006) deal with this selection issue by incorporating the inverse Mills ratio (IMR). The same strategy is employed in our estimation, which is elaborated on in Section 4.

3 Background

In this section, we discuss some backgrounds related to marriage and lifestyle in South Korea. We consider that institutional and cultural distinctions would lead to different results compared to previous investigations. First, compared to Western countries, premarital cohabitation is less popular in Korea. Although there are no national statistics on alternative forms of partnership, some surveys reveal that the majority of the Korean population over the age of 40 is not favorable to cohabitation of unmarried couples (Appendix A)[1]. The rarity of cohabitation is also indirectly supported by the fact that Korea shows a relatively higher crude marriage rate among OECD member states (Appendix B). One may expect that this fact somehow weakens premarital resemblance or assortative mating over lifestyle preference.

[1]Public opinion has gradually changed over time as well as along with a new generation. As of 2012, about 60% of people below age 40 have a positive attitude towards cohabitation.

Supporting this hypothesis, from a cross-sectional analysis on 3,141 Korean married couples, Kim et al.(2006) find that spousal concordance of metabolic risk factors is relatively weaker among younger couples. From this finding they conclude that cohabitation effect may outweigh assortative mating.

Second, in spite of conservative social attitude towards marriage, the crude rate of divorce in Korea is not particularly lower than among OECD countries (Appendix C). Overall, incidence of divorce is highest among the couples whose duration of marriage is less than 5 years. More than half of divorced couples spend less than 10 years together (Appendix D)[2]. Regardless of age groups, personality difference is the most common reason for marital dissolution (Appendix E). Although personality difference relates to various situations in reality, we cannot exclude the possibility that it also embraces dissonance in lifestyle. If so, there might be self-selection among divorcées or the separated. This fact strengthens our justification for incorporating IMR into the model following Clark and Etilé (2006).

Third, among OECD member states, Korea shows relatively high rates of male smoking and alcohol consumption (Appendix F). In addition, compared to Western societies, this behavior diverges more between men and women. This gap is mainly due to negative social perception of female smoking as well as alcohol consumption to a lesser extent. For the same reason, there is a huge discrepancy between females' self-reported smoking status and urine examination results (Park et al., 2014). In national surveys, the rate ranged between 1.8% (Adult Smoking Status Investigation[3]) and 6.8% (National Health and Nutrition Examination Survey[4]) in 2011 (No Smoking Guide). However, examination results indicated 13.6% in the same year (Park et al., 2014). On the other hand, in terms of the gender difference in sports participation, the gap between men and women is much smaller.

According to the Health Insurance Policy Research Institute, the socioeconomic cost of unhealthy lifestyles has steadily increased from 13.5 trillion won in 2005 to 21.6 trillion won in 2011 in Korea. The biggest cost was induced by drinking, which accounts for 9.4 trillion won, followed by smoking (7.1 trillion won) and obesity-related costs (6.7 trillion won) in 2013. Medical expenses took up the largest portion (39.1%) among all types of costs such as lost earnings due to premature death, lost productivity, etc. (Lee et al., 2015). To prevent risky behavior, the government has taken several measures, such as the extension of smoke-free areas, an increase in the price of tobacco, restrictions on alcohol advertisement, etc. Considering heavy social burdens, our attempt to answer the question of whether the

[2] Nonetheless, a relative proportion of marital dissolution after 20 years of marriage exhibits a stable increase between 2005 and 2012.

[3] This survey is conducted by the Korea Association of Smoking or Health based on a telephone survey. The number of female respondents was 1,518.

[4] The Centers for Disease Control and Prevention lead this annual survey. Smoking status is surveyed through a computer-assisted self-interview.

effect of such interventions can be amplified through the "social multiplier" effect (Glaeser, Sacerdote, and Scheinkman, 2003) has important policy relevance.

4 Data

We use data from the Korean Labor & Income Panel Study (KLIPS), which is the longest longitudinal survey in Korea. The survey has been conducted on an annual basis since it was launched in 1998. It provides detailed information on individuals and households regarding economic activity such as training/education, job search/mobility/satisfaction, workplace characteristics, employment contracts, wage and income. In addition, modules on health status and lifestyle have been added since 2005. We use the balanced sample between 2005 and 2014, which consists of those who have maintained stable marriage throughout (17,650 couples)[5].

Even if we are primarily interested in a spousal interaction given a stable partnership, we consider potential self-selection among the balanced sample, or reversely, dropouts including the separated/divorcées. Following Clark and Etilé (2006)'s strategy, as mentioned in earlier sections, we introduce the inverse Mills ratio (IMR) into our model as an extra control variable. We introduce gender-specific models of sample selection where the probability to appear in a balanced sample is a dependent variable. As independent variables, the models contain education, age group of children, province of residence, health status, working status, and year dummies. The annual regional unemployment rate is added for exclusion restriction. The estimation results are displayed in Appendix H.

Our dependent variables are health-related risky behavior such as sedentariness, smoking and drinking. We dichotomize three original variables to implement probit estimation (See Table 1 for details.). The independent variables are age (divided by 100), birth cohort, education, religion, current health status (i.e. difficulties with mobility, memory, indoor/outdoor activity and working), province of birth, father's education, age at marriage, remarriage status, working status, household income per capita, children's age group (0-3, 4-6, 7-12, 13-18, 19 years old or over), province of current residence, and year dummies. In addition, we also consider both the individual's and spouse's self-reported health shock (0 for better or same and 1 for worse compared to the previous year) to investigate altruism or learning as an indirect mechanism. The full list of variables and their summary statistics are exhibited in Appendix G.

[5]By retrieving information on marital history and relationship to the head of household, we transform the unit of observation into a household (or partnership) and append ten waves into a long format.

5 Descriptive analysis

Before implementing econometric estimation, we conduct two pretests based on descriptive information to check 1) whether behavior between spouses is related and 2) whether individuals are systematically different according to their lifestyle choice.

5.1 Unconditional vs. conditional probabilities

To find an answer to the first question, we compare probabilities of an individual choosing a certain lifestyle, Y_i, before and after conditioning on her/his spouse's behavior, Y_j. The former is also called a marginal probability which is denoted by $P(Y_i)$. In the case of cigarette smoking, for instance, $P(Y_i)$ simply refers to a proportion of smokers in gender-specific samples. The latter is computed in eq. (1), where the numerator, $P(Y_i \cap Y_j)$, refers to the joint probability that we observe a pair of Y_i and Y_j. The difference between $P(Y_i)$ and $P(Y_i|Y_j)$ hints that Y_i and Y_j are dependent. In this analysis, we pool samples from ten waves.

$$P(Y_i|Y_j) = \frac{P(Y_i \cap Y_j)}{P(Y_i)} \tag{1}$$

Table 1 presents both probabilities. In terms of a marginal probability, it is shown that roughly equal proportions of married women (70.02%) and men (65.14%) were physically inactive between 2005 and 2014. On the other hand, we notice a substantial gender gap in smoking and drinking behavior. For example, the prevalence of smoking is less than 1% among women but 45.77% among men. Considering the fact that smoking is attributed to "unfit mothers and wives" in Korea (Kim et al. 2005), it is not surprising to observe an even lower smoking rate in our data, which selects for women in a stable marriage. This under-reported smoking status of wives is a critical limitation in our data and investigation. Having no alternative measure, we maintain this variable in our analyses but redefine its meaning as uninhibited willingness to smoke in public in the case of female respondents. The gender gap is less pronounced in terms of drinking. 36.25% of women and 75.99% of men reported that they consumed alcoholic beverages.

Table 1: Conditional and unconditional probability of lifestyle choice (%)

	Wife $Y_i = 0$	Wife $Y_i = 1$	Husband $Y_i = 0$	Husband $Y_i = 1$	Coding
$P(Y_i)$ of sedentariness	29.98	70.02	34.86	65.14	
$P(Y_i \mid Y_j = 0)$	52.06	47.94	60.53	39.47	0: irregularly/regularly exercise
$P(Y_i \mid Y_j = 1)$	18.17	81.83	23.87	76.13	1: never/rarely exercise*
$P(Y_i)$ of smoking	99.31	0.69	54.23	45.77	
$P(Y_i \mid Y_j = 0)$	99.54	0.46	54.35	45.65	0: never smoked or quit smoking
$P(Y_i \mid Y_j = 1)$	99.03	0.97	36.07	63.93	1: currently smoking
$P(Y_i)$ of drinking	63.75	36.25	24.01	75.99	
$P(Y_i \mid Y_j = 0)$	83.36	16.64	31.40	68.60	0: never drank or quit drinking
$P(Y_i \mid Y_j = 1)$	57.55	42.45	11.02	88.98	1: currently drinking

- Note: * In the survey, there are three proceeding questions regarding personal method of health maintenance. If exercising is never chosen in these questions, we consider that a respondent never or rarely exercise.

Next, we compare unconditional and conditional probabilities. Regarding sedentariness, we find a relatively higher conditional probability for both wives and husbands to choose the same lifestyle as their partners. For instance, a wife's probability to be sedentary increases from 70.02% to 81.82% if her husband is also sedentary. For a husband, the same probability increases from 65.14% to 76.13% by his wife's behavior. The jump is approximately 10 percentage points for both groups. Similarly, the probability of an individual to engage in exercise rises from 29.98% to 52.06% for wives and from 34.86% to 60.53% for husbands. The difference between each of the two probabilities is greater than 20 percentage points. We observe similar patterns in terms of drinking behavior. In the case of a couple's joint non-participation, the probability of an individual abstaining from drinking increases from 63.75% to 83.36% for females and from 24.01% to 31.40% for males. The magnitude of change is more pronounced among females. When a couple jointly participates in alcohol consumption, women's tendency to drink rises from 36.25% to 42.45% and that of men from 75.99% to 88.98%. In this case, men show a more marked difference.

We find a different result with respect to smoking. A wife's probability of smoking is less than 1% regardless of their spousal status. In other words, the choice of women to not smoke is nearly independent of their partners' behavior. It is presumably attributed to the strong negativism towards female smoking in Korean society (See Section 3) or measurement errors in wives' smoking status. On the other hand, a husband's probability of smoking becomes higher in the case of his wife's joint participation (45.77% vs. 63.93%). Overall, in some way, this exercise supports the presence of spousal interaction or bargaining in lifestyle formation.

5.2 Sample characteristics by lifestyle

Concerning the second question, we compare individual and household characteristics between the subgroups according to their gender and lifestyle (Table 2). First of all, we find that people tend to avoid risky lifestyles when they experience a decline in their own health status. Females' smoking decision is the only exception, showing an opposite pattern. However, without being aware of a causal link, it is also possible that their worsened health condition is a result of their smoking behavior. A negative relationship between risky behavior and health problems is found with respect to each functional limitation. When spousal health has deteriorated, we observe a lower prevalence of risky behavior.

People show different demographic characteristics according to their lifestyle choices. For instance, older age is related to lower prevalence of risky behavior, except for females' smoking status. In general, those who are religious are less likely to choose a risky lifestyle. Regardless of age group, having children is related to riskier behavior. The differentials increase with children's age. As an exception, married women's prevalence of smoking is smaller if children are younger than 13 years old or older than 19 years old.

We also find socioeconomic disparities in lifestyle choice. Those who work tend to choose risky behavior compared to their counterparts. Work-related stress can be one of reasons. People with higher education and household income are less likely to be sedentary and smoke but are more likely to drink alcohol. The relationship between paternal education and lifestyle differs. Except for males' exercise decision, people with a more highly educated father tend to choose riskier behavior.

Lastly, we do not find any visible difference in terms of age of marriage or remarriage status among people practicing different lifestyles. In other words, it seems that there is no selection in terms of timing of marital formation in the marriage market, according to personal preference over lifestyle. However, we retain these variables in the main analysis to control for differences in marital duration indirectly[6].

In our main analysis, by controlling these confounding factors as well as unobserved heterogeneity, we attempt to identify whether this interaction is causal, how important the spousal influence is, and whose role is more important.

[6]Considering potential multicollinearity between marital duration and age, we do not include a direct measure of length of marriage.

Table 2: Individual and household characteristics by gender and lifestyle (mean)

	Sedentariness				Smoking				Drinking			
	Wife		Husband		Wife		Husband		Wife		Husband	
	$Y_i = 0$	$Y_i = 1$	$Y_i = 0$	$Y_i = 1$	$Y_i = 0$	$Y_i = 1$	$Y_i = 0$	$Y_i = 1$	$Y_i = 0$	$Y_i = 1$	$Y_i = 0$	$Y_i = 1$
Health shock	0.12	0.13	0.10	0.12	0.13	0.18	0.13	0.09	0.16	0.08	0.19	0.09
Spousal health shock	0.10	0.12	0.12	0.13	0.11	0.08	0.15	0.11	0.13	0.09	0.16	0.12
Age	52.26	50.70	55.41	53.99	51.16	52.39	57.20	51.26	53.64	46.83	59.25	52.97
Educational degree (1 none-5 university)	2.77	2.55	3.39	2.93	2.62	2.17	3.09	3.10	2.47	2.86	2.97	3.13
Religion=none/other	0.35	0.43	0.49	0.55	0.41	0.66	0.49	0.58	0.37	0.48	0.43	0.56
=Buddhist	0.30	0.27	0.23	0.23	0.28	0.22	0.23	0.24	0.27	0.28	0.21	0.24
=Christian	0.35	0.30	0.28	0.21	0.32	0.11	0.28	0.18	0.36	0.23	0.35	0.20
Difficult mobility (vs. none)	0.07	0.07	0.06	0.07	0.07	0.11	0.09	0.04	0.09	0.04	0.14	0.04
Difficult remembering (vs. none)	0.03	0.03	0.04	0.04	0.03	0.03	0.05	0.02	0.04	0.02	0.08	0.02
Difficult indoor activity (vs. none)	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.00	0.04	0.01
Difficult outdoor activity (vs. none)	0.02	0.03	0.02	0.03	0.03	0.05	0.04	0.01	0.04	0.01	0.08	0.01
Difficult working (vs. none)	0.12	0.10	0.10	0.10	0.11	0.14	0.13	0.06	0.14	0.05	0.20	0.07
Father's education=Secondary (vs. below)	0.23	0.24	0.26	0.22	0.24	0.30	0.21	0.25	0.24	0.25	0.21	0.24
Age at marriage	23.99	23.97	27.27	27.24	23.97	24.02	27.18	27.33	23.89	24.11	27.17	27.27
Remarried	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02
Working status (vs. none)	0.37	0.56	0.37	0.56	0.50	0.51	0.73	0.84	0.45	0.59	0.65	0.82
HH income (1,000 Won)	193.72	162.07	197.13	157.88	171.71	150.77	172.01	171.03	160.17	191.59	145.59	179.77
Child 0-3 years old	0.03	0.08	0.05	0.07	0.06	0.02	0.05	0.08	0.05	0.08	0.04	0.07
Child 4-6 years old	0.06	0.09	0.07	0.09	0.08	0.02	0.06	0.10	0.07	0.11	0.05	0.09
Child 7-12 years old	0.17	0.20	0.18	0.20	0.19	0.16	0.15	0.23	0.16	0.25	0.14	0.21
Child 13-18 years old	0.22	0.23	0.22	0.23	0.23	0.28	0.19	0.27	0.19	0.29	0.17	0.24
Child over 19 years old	0.50	0.56	0.52	0.56	0.54	0.45	0.47	0.62	0.47	0.67	0.41	0.58
Observation	5,292	12,358	6,153	1,1497	17,528	122	9,571	8,079	11,251	6,399	4,238	13,412

- Note: In a main analysis, each category of educational degree is controlled. Birth cohort/place and current residence are omitted due to space limitations.

6 Method

Our main analysis begins with a univariate dynamic model by assuming that a husband and a wife's individual-specific heterogeneity and contemporaneous shocks are independent from each other's. Next, we extend the model into a bivariate specification to demonstrate the importance of correlated unobserved factors.

6.1 Univariate dynamic probit

We consider the following stochastic process where individual $i(i = 1, ..., N)$'s behavior (i.e. smoking, drinking or exercising) at time $t(t = 2, ..., T)$ is shaped by both the individual's and spouse's lagged behavior denoted as $Y_{i,t-1}$ and $Y_{j,t-1}(j = 1, ..., N \ and \ i \neq j)$ respectively, and the vector of individual and household characteristics, X_i (eq. 2). The parameter of $Y_{i,t-1}$ captures state-dependency or addiction and that of $Y_{j,t-1}$ indicates spousal spill-over or peer effect. e_i depicts individual-specific random effects and $\varepsilon_{i,t}$ captures idiosyncratic shock.

$$Y^*_{i,t} = \alpha Y_{i,t-1} + \beta Y_{j,t-1} + X^{'}_{i,t}\gamma + e_i + \varepsilon_{i,t}$$
$$Y_{i,t} = \begin{cases} 1 \quad if \quad Y^*_{i,t} > 0 \\ 0 \quad if \quad Y^*_{i,t} \leq 0 \end{cases} \tag{2}$$

In this specification, we encounter the "initial conditions" problem which relates to the question of whether those who were sedentary, smoked or drank at $t = 1$ are randomly drawn from the population. If not, meaning that $Y_{i,1}$ is correlated with e_i, we cannot estimate α consistently. Having no information about $Y_{i,0}$, however, we need an assumption about the relationship between $Y_{i,1}$ and e_i. We adopt Wooldridge (2005)'s simple approach that considers conditional distribution of e_i given $Y_{i,1}$ and $\overline{X_i}$. The latter encompasses time-invariant X as well as longitudinal-mean of time-varying X. The auxiliary model of e_i is specified as Eq. (3).

$$e_i = \eta Y_{i,1} + \overline{X}^{'}_i\delta + u_i \tag{3}$$

u_i depicts unobserved individual heterogeneity which is uncorrelated with $Y_{i,1}$ and thus also with $Y_{i,t-1}$. After plugging this in e_i, we obtain the following specification. We assume that u_i is drawn from a finite mixture distribution (Heckman and Singer, 1984). We approximate u_i as $\theta_k(k = 1, ..., K)$, which are randomly and discretely distributed with corresponding probabilities, $\pi_k(\pi_k = \frac{exp(\theta_k)}{1+exp(\theta_k)})$ summing to 1. In other words, we consider that the population consists of k subgroups who share the same latent class (i.e. constant term) among themselves. We find that our model converges best when $K = 2$. The contemporaneous shock $\varepsilon_{i,t}$ is assumed to be distributed i.i.d. $N(0, \sigma_\varepsilon)$.

$$Y^*_{i,t} = \alpha Y_{i,t-1} + \beta Y_{j,t-1} + X^{'}_{i,t}\gamma + \eta Y_{i,1} + \overline{X}^{'}_{i}\delta + u_i + \varepsilon_{i,t}$$
$$Y_{i,t} = \begin{cases} 1 & if \quad Y^*_{i,t} > 0 \\ 0 & if \quad Y^*_{i,t} \leq 0 \end{cases} \tag{4}$$

We estimate this univariate model separately for the samples of husbands and wives in order to compare gender differences.

6.2 Bivariate dynamic probit

The univariate model can be extended to a bivariate setting by allowing cross-correlations between time-invariant and -variant unobserved factors, u and ε between i and j. The correlation between u_i and u_j reveals the presence of assortative mating and/or a shared environment that does not vary over time. The link between $\varepsilon_{i,t}$ and $\varepsilon_{j,t}$ indicates common unobserved shocks at each period. In a bivariate approach, Wooldridge (2005)'s specification of e_i and e_j is modified into eq. (5) by adding spousal initial condition. It is because e_i, which is assumed to not be independent of e_j, is also correlated with $Y_{j,1}$ due to the link between $Y_{j,1}$ and e_j.

$$\begin{aligned} e_i &= \eta_I Y_{i,1} + \lambda_I Y_{j,1} + \overline{X}^{'}_{i}\delta_I + u_i \\ e_j &= \eta_J Y_{j,1} + \lambda_J Y_{i,1} + \overline{X}^{'}_{j}\delta_J + u_j \end{aligned} \tag{5}$$

The final model is expressed as eq. (6).

$$\begin{aligned} Y^*_{i,t} &= \alpha_I Y_{i,t-1} + \beta_I Y_{j,t-1} + X^{'}_{i,t}\gamma_I + \overline{X}^{'}_{i}\delta_I + \eta_I Y_{i,1} + \lambda_I Y_{j,1} + u_i + \varepsilon_{i,t} \\ Y^*_{j,t} &= \alpha_J Y_{j,t-1} + \beta_J Y_{i,t-1} + X^{'}_{j,t}\gamma_J + \overline{X}^{'}_{j}\delta_J + \eta_J Y_{j,1} + \lambda_J Y_{i,1} + u_j + \varepsilon_{j,t} \end{aligned}$$

$$Y_{i,t} = \begin{cases} 1 & if \quad Y^*_{i,t} > 0 \\ 0 & if \quad Y^*_{j,t} \leq 0 \end{cases} \quad Y_{j,t} = \begin{cases} 1 & if \quad Y^*_{j,t} > 0 \\ 0 & if \quad Y^*_{j,t} \leq 0 \end{cases} \tag{6}$$

Similarly with the univariate model, we assume that a pair of approximated values of u_i and u_j, denoted as $\theta_{I,k}$ $(k = 1, .., K)$ and $\theta_{J,m}$ $(m = 1, .., M)$, are randomly and discretely distributed with associated probabilities, $\pi_{km} = Pr(u_i = \theta_{I,k}, u_j = \theta_{J,m})$ summing to 1. Our model converges best when we assume $K = 2$ and $S = 2$, which results in four pairs of θ_I and

θ_J. Concerning $\varepsilon_{i,t}$ and $\varepsilon_{j,t}$, we assume a bivariate normal distribution which is expressed as eq. (7), where ρ_ε represents a correlation between two contemporaneous shocks.

$$\begin{pmatrix} \varepsilon_{i,t} \\ \varepsilon_{j,t} \end{pmatrix} = N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho_\varepsilon \\ \rho_\varepsilon & 1 \end{pmatrix}\right] \tag{7}$$

Finally, the log-likelihood function is expressed as Eq.(8), where Z_i and Z_j are the vectors of characteristics describing i and j respectively. Parameters, α, β, γ, δ, η, λ and θ are estimated by the maximum likelihood method.

$$logL = \sum_{ij=1}^{N} log\left\{\sum_{k=1}^{K}\sum_{m=1}^{M}\pi_{km}\cdot\prod_{t=1}^{T}P_{ij,t}(Y_{i,t}, Y_{j,t}|Y_{i,t-1}, Y_{j,t-1}, Z_i, Z_j, u_i = \theta_{I,k}, u_j = \theta_{J,m})\right\} \tag{8}$$

6.3 Partial Effect

In addition to estimated parameters, we compute the partial effect of the main regressors $Y_{i,t-1}$ and $Y_{j,t-1}$. We follow Kano (2008)'s approach, which extends the partial effects into different timelines. This exercise is helpful for drawing policy implications as it allows us to quantify the importance of path dependency and spousal effect and compare gender differences.

In a non-linear model, a partial effect of one variable depends on values of the others. Therefore, researchers often calculate the partial effect of a main regressor by fixing other covariates (e.g. at means), or they average the partial effects across an entire population. Instead of the former method that computes a partial effect of an arbitrary individual, we consider that the effect averaged over population characteristics has more important policy relevance. In addition, when panel data is employed, the presence of unobserved heterogeneity and its correlation with observed characteristics are additional concerns. One can assume either unconditional (or fixed) distribution of the heterogeneity (Wooldridge, 2005b) or conditional distribution by letting it vary with covariates (Altonji and Matzkin, 2005). We take the latter approach, which produces the average local response (ALR) coined by Abrevayay and Hsuz (2011)[7].

We compute the ALR of a regressor of our interest in the latest year, 2014 ($t = 10$). Following Kano (2008)'s notations, we denote the vector of other covariates as Ω_{10}. For

[7]According to their classification, Kano (2008)'s estimation is the conditional average local response (CALR) rather than APE. The author fixed other covariates at cross-sectional means.

example, the ALR of $Y_{i,9}$ for the probability that $Y_{i,10}$ equals 1 is expressed in eq. (9).

$$ALR(Y_{i,9}) \quad = \quad E(Y_{i,10}|Y_{i,9}=1,\Omega_{i,10}) - E(Y_{i,10}|Y_{i,9}=0,\Omega_{i,10}) \tag{9}$$

We let

$$\mu_{i1} = \Phi(\alpha_I + \beta_I Y_{j,9} + X_{i,t}^{'}\gamma_I + \overline{X}_i^{'}\delta_I + \eta_I Y_{i,1} + \lambda_I Y_{j,1} + \tilde{\theta}_i)$$
$$\mu_{i0} = \Phi(\beta_I Y_{j,9} + X_{i,t}^{'}\gamma_I + \overline{X}_i^{'}\delta_I + \eta_I Y_{i,1} + \lambda_I Y_{j,1} + \tilde{\theta}_i).$$

and re-express APE as eq. (10). ALR is consistently estimated by its sample analogue, $\widehat{ALR}$ in eq. (11).

$$ALR(Y_{i,9}) = E\left[\mu_{i1} - \mu_{j0}\right] \tag{10}$$

$$\widehat{ALR}(Y_{i,9}) = \frac{1}{N}\sum_{i=1}^{N}(\mu_{i1} - \mu_{j0}) \tag{11}$$

$\tilde{\theta}_i$ is individual-specific heterogeneity that is estimated as follows. First, using Bayes theorem, we compute posterior probabilities,$\widetilde{\pi}_{i,k}$, for each i to fall under the Type k.

$$\begin{aligned} \widetilde{\pi}_{i,k} \quad &= \quad Pr(\theta_i = \theta_{I,k}|Y_{i,10},Y_{i,9},Y_{j,9},X_{i,10}^{'},\overline{X}_i^{'},Y_{i,1},Y_{j,1}) \\ &= \quad \frac{\pi_k \cdot f(Y_{i,10}|Y_{i,9},Y_{j,9},X_{i,10}^{'},\overline{X}_i^{'},Y_{i,1},Y_{j,1},\theta_i=\theta_{I,k})}{\sum_k \pi_k \cdot f(Y_{h,10}|Y_{i,9},Y_{j,9},X_{i,10}^{'},\overline{X}_i^{'},Y_{i,1},Y_{j,1},\theta_i=\theta_{I,k})} \\ where \qquad & \pi_k = \sum_{m=1}^{M}\pi_{km} \end{aligned} \tag{12}$$

Next, we approximate $\tilde{\theta}_i$ with an individual-specific posterior mean as shown in eq. (13).

$$\tilde{\theta}_i = \sum_{k=1}^{K}\widetilde{\pi}_{i,k}\cdot\theta_{I,k} \tag{13}$$

By adapting the Kano (2008) approach, we employ ALR on survival ($ALRS$) in the next period, $10+s(s=1,...,S)$, to explore the short or mid-term effects of a regressor. Under the conditional independence assumption, $ALRS$ of $Y_{i,9}$ on the probability that $Y_{i,10+s}=1$ is expressed as eq. (14). We fix the set of covariates in the next periods, $\Omega_{i,10+s}$, as their values in the latest year, which is simplified to $\Omega_{i,10}$.

$$
\begin{aligned}
&Pr(Y_{i,10}=1, Y_{i,11}=1, .., Y_{i,10+S}=1|Y_{i,9}=1, \Omega_{i,10}, .., \Omega_{i,10+s}) \\
&= \textstyle\prod_{s=1}^{S} Pr(Y_{i,10+s}=1|Y_{i,10+s-1}=1, \Omega_{i,10}) \\
&\times Pr(Y_{i,10}=1|Y_{i,9}=1, \Omega_{i,10}) \\
&= {\mu_{i1}}^{S+1}
\end{aligned} \tag{14}
$$

Likewise, the survival probability given $Y_{i,9}=0$ is expressed in eq. (15).

$$
\begin{aligned}
&Pr(Y_{i,10}=1, Y_{i,11}=1, .., Y_{i,10+S}=1|Y_{i,9}=0, \Omega_{i,10}, .., \Omega_{i,10+s}) \\
&= \left[\textstyle\prod_{s=1}^{S} Pr(Y_{i,10+s}=1|Y_{i,10+s-1}=1, \Omega_{i,10})\right] \\
&\times Pr(Y_{i,10}=1|Y_{i,9}=0, \Omega_{i,10}) \\
&= {\mu_{i1}}^{S}.\, \mu_{i0}
\end{aligned} \tag{15}
$$

After subtracting eq. (15) from eq. (14), we obtain $ALRS$ of $Y_{i,9}$ at $10+s$.

$$
ALRS(Y_{i,9}) = E\left[{\mu_{i1}}^{S}\left(\mu_{i1}-\mu_{i0}\right)\right] \tag{16}
$$

In addition, as Kano (2008) proposes, we compute the accumulated $ALRS$ up to $t=\infty$, namely the average long-run local response ($ALRLR$). Since $\lim_{S\to\infty}\sum_{s=1}^{S} {\mu_{i1}}^{S} = \frac{\mu_{i1}}{1-\mu_{i1}}$, $ALRLR$ is expressed as in eq. (17).

$$
ALRLR(Y_{i,9}) = E\left\{\frac{\mu_{i1}}{1-\mu_{i1}}\left(\mu_{i1}-\mu_{i0}\right)\right\} \tag{17}
$$

We average $ALRS$ and $ALRLR$ over n individuals to estimate $\widehat{ALRS}$ and $\widehat{ALRLR}$. Standard errors are estimated by the Delta-method (see Appendix in Kano (2008) for details).

7 Estimation Result

Tables 3-7 show estimated coefficients of main explanatory variables regarding sedentary lifestyle (or non-exercising), as well as smoking and drinking status, respectively. Full results from the bivariate model that is our final specification are presented in Appendices I-J[8]. Based on estimated parameters, we discuss the different mechanisms of path dependency and spousal peer effect.

[8]Corresponding results from the univariate model can be provided upon request.

7.1 Sedentariness

In Table 3, we find a strong positive correlation between θ_i and θ_j regarding sedentary lifestyle, which is as high as 0.582[9]. This result implies the presence of assortative mating over preference for physical (in)activity. In addition, a significant ρ_ϵ indicates the presence of common idiosyncratic shocks, which shifts both partners' sedentary status in the same direction. One of the examples is a situation where both spouses decrease their physical activity when another household member is sick. The significant correlations between time-invariant unobserved heterogeneities of both spouses imply that a bivariate model is more appropriate. Therefore, our results are mainly discussed based on the final specification.

The result from the bivariate model demonstrates path dependency by showing that an individual's past behavior is positively correlated with current sedentariness. Furthermore, a significant role of spousal past behavior suggests bargaining between couples. The indirect spillover effect that works through spousal health is observed among married women only. They tend to become more sedentary when their spouse reported worsened health. It may be related to their involvement in care activity for ill spouses, which limits their time for exercising. On the other hand, husbands are not sensitive to the deterioration of spousal health but to that of their own condition. When their self-perceived health condition is worsened, they are more likely to be sedentary. It might be related to a direct constraint on mobility due to their illness.

We observe that females in stable marital relationship are more likely to exercise (less likely to be sedentary), but their male counterparts show the opposite behavior. This finding is somewhat in line with many studies that report positive contribution of marriage to body weight, where the gain is greater for males (e.g. Sobal et al. 2003; Berge et al., 2014; Teachman, 2016).

[9]Farrell and Shields (2002)'s calculation of intra-household correlation in sport participation based on British data is 0.357.

Table 3: The effect of individual and spousal past behavior on sedentary lifestyle

	Univariate				Bivariate			
	Wife		Husband		Wife		Husband	
$Y_{i,t-1}$	0.280**	(0.027)	0.411**	(0.025)	0.291**	(0.020)	0.423**	(0.022)
$Y_{i,1}$	0.119	(0.174)	0.119	(0.173)	0.119	(0.134)	0.119	(0.134)
$Y_{j,t-1}$	0.169**	(0.014)	0.147**	(0.019)	0.153**	(0.021)	0.130**	(0.017)
$Y_{j,1}$					0.119	(0.134)	0.119	(0.134)
$\triangle H_{i,t}$	-0.002	(0.015)	0.083**	(0.017)	0.005	(0.014)	0.074**	(0.018)
$\triangle H_{j,t}$	0.115**	(0.016)	0.000	(0.016)	0.113**	(0.016)	0.004	(0.017)
IMR	-0.135**	(0.017)	0.201**	(0.040)	-0.137**	(0.022)	0.333**	(0.104)
θ_1	0.202**	(0.021)	-0.548**	(0.058)	0.296**	(0.040)	-0.976**	(0.085)
θ_2	1.133**	(0.033)	-1.509**	(0.066)	1.224**	(0.045)	-1.929**	(0.087)
π_1	0.390		0.616		πs are presented in Table 4.			
π_2	0.610		0.384		$Corr(\tilde{\theta}_i, \tilde{\theta}_j)$=0.582			
ρ_ϵ					0.491** (0.013)			

Significance level:+p<0.10, * p<0.05, ** p<0.01

Table 4 presents individual-specific heterogeneities that are approximated via a bivariate specification and each of the corresponding probabilities. For notational simplicity, we denote heterogeneity of the wives' group as θ_W and that of the husbands' group as θ_H. Our result displays a noticeable distance between mass points that approximate random effects of each spouse. This means that both a wife and a husband's time-invariant unobserved heterogeneity is clearly diverged into two types. A higher value of intercept can be interpreted as a relatively stronger unwillingness to exercise. It is shown that about 48.6% of our sample consists of more sedentary wives and husbands. On the other hand, in 24.6% of partnerships, both spouses have a stronger preference for exercise.

Table 4: Probability of each of the pairs of unobserved heterogeneity in the bivariate model

	θ_{H1} = -0.976**	θ_{H2} = -1.929**
θ_{W1} = 0.296**	$\pi_{11} = 0.135$	$\pi_{12} = 0.246$
θ_{W2} = 1.224**	$\pi_{21} = 0.486$	$\pi_{22} = 0.134$

The full results in Appendix I is mostly consistent with Farrell and Shields (2002)'s findings from British household data, but with few exceptions. For instance, while they find decreasing propensity to exercise with age, we find an opposite pattern among females. In our data, either older ages or earlier birth cohorts are positively correlated with their physical activity. Farrell and Shields (2002) report a positive role of having a child and a negative role of having an infant (below age 2) in sport participation. They interpret this mixed pattern to mean that 'family commitment' may constrain time for exercise but also increase demand for joint outdoor activities. From Korean households, on the other hand, we find a mostly negative impact of having a child on exercising. It may be due to the fact that childcare-related time or budget constraints outweighs the need or opportunity for joint activities. Furthermore, while the authors find no geographical difference in the UK, we generally observe that couples residing in Seoul are more committed to exercise compared to residents in other provinces. Further investigation is needed to identify the reason for such a geographical gap.

We observe a negative correlation of education and income with sedentariness, which is consistent with Farrell and Shields (2002)'s finding. Religion also plays a negative role in sedentary status. On the other hand, working status increases the probability to be sedentary. This finding is plausible if working hours offset available time for physical activity. Our results also suggest that those who married later or those who are remarried are less likely to exercise. However, it can also be interpreted that those who abstain from physical activity are more likely to marry later, or that they self-select out of marriage (e.g. divorce) and remarry.

7.2 Smoking

From Table 5, we find only a weak correlation between θ_i and θ_j (0.037) in terms of smoking. However, considering a significant ρ_ϵ, which implies the importance of a shared environment, we still prefer the bivariate specification. The size of spousal correlation in terms of time-varying heterogeneity is less pronounced compared to the earlier case of sedentary lifestyle.

Based on a bivariate model, we observe a statistically strong state-dependency or addiction in terms of smoking. Unlike females, smoking status in the initial period is more important than the status of the previous year for males. However, this result should be interpreted with caution since $Y_{i,1}$ captures not only the initial smoking status but also other fixed characteristics that are presumably correlated with behaviors in the following periods. Therefore, it does not necessarily imply that an anti-smoking policy is more effectively implemented by preventing the initial trial of smoking at $t = 1$ rather than by weakening the channel of addiction.

Regarding a spousal effect, we find that current smoking decision is significantly affected by spousal past behavior. The spousal influence differs by gender. Females are discouraged from smoking by their smoking spouse but males are instead encouraged. In addition to direct bargaining, this finding may be related to a mechanism of social learning. For instance, a wife may be alarmed at an undesirable consequence of smoking from her smoking partner. On the other hand, a husband may be inclined to smoke by his smoking partner because he feels happier when he smokes with someone or he learns that the risk of smoking is bearable.

However, it is important to note that this interpretation only applies to a small fraction of couples since, according to our data, few women smoke publicly.

We find further evidence of altruism or learning through a significantly negative correlation between smoking and adverse shocks on spousal health. Females' reaction is more pronounced, which is consistent with Mcgeary (2015) and Canta and Dubois (2015)'s findings from American and French couples, respectively. We observe opposite correlations between smoking behavior and marital stability (IMR) between gender. The correlation is positive for women but negative for men. Considering the adverse effects of smoking on health (Ezzati and Lopez, 2003) and economic outcomes (Levine et al. 1997), the result from the male sample is more plausible. Females' positive correlation is rather unexpected, yet it is applicable to exceptional cases comprising less than 1% of the sample.

Table 5: The effect of individual and spousal past behavior on smoking

	Univariate				Bivariate			
	Wife		Husband		Wife		Husband	
$Y_{i,t-1}$	0.710**	(0.196)	0.966**	(0.030)	1.025**	(0.107)	0.966**	(0.021)
$Y_{i,1}$	0.119	(0.614)	3.779**	(0.051)	0.191	(0.177)	3.679**	(0.040)
$Y_{j,t-1}$	-0.109	(0.080)	0.217	(0.144)	-0.054**	(0.004)	0.190**	(0.039)
$Y_{j,1}$					-5.790**	(0.093)	0.191	(0.177)
$\triangle H_{i,t}$	-0.179	(0.321)	-0.008	(0.033)	-0.128**	(0.007)	0.052	(0.006)
$\triangle H_{j,t}$	-0.179	(0.162)	0.053	(0.056)	-0.296**	(0.012)	-0.008**	(0.005)
IMR	2.198+	(1.204)	-0.791**	(0.110)	1.695**	(0.046)	-0.785**	(0.022)
θ_1	-6.942*	(3.097)	-0.104**	(0.033)	-8.688	(60.262)	1.121**	(0.020)
θ_2	-9.966**	(3.215)	1.049**	(0.045)	0.151**	(0.011)	-0.032**	(0.003)
π_1	0.095		0.550		πs are presented in Table 6.			
π_2	0.905		0.450		$Corr(\tilde{\theta}_i, \tilde{\theta}_j)$=0.037			
ρ_ϵ					0.163** (0.005)			

Significance level:+p<0.10, * p<0.05, ** p<0.01

We consider four pairs of time-invariant unobserved heterogeneity of a wife and a husband (θ_H and θ_W). Table 6 shows their approximated values and corresponding probabilities. In the case of females, only one mass point is identifiable (θ_{W2}), which represents 13.7% ($\pi_{21} + \pi_{22}$) of their sample. For the rest, their unobserved characteristics are too dispersedly distributed. Among males, we find two types of heterogeneity, which are approximated to be 1.121 and -0.032 respectively. A husband with the former type is considered to be relatively more prone to smoking. 86.3% ($\pi_{11} + \pi_{12}$) of the partnership consists of a wife with an unidentifiable type (θ_{W1}) and a husband with either type.

Table 6: Probability of each of the pairs of unobserved heterogeneity in the bivariate model

	θ_{H1} = 1.121**	θ_{H2} = -0.032**
θ_{W1} = -8.688	$\pi_{11} = 0.373$	$\pi_{12} = 0.490$
θ_{W2} = 0.151**	$\pi_{21} = 0.077$	$\pi_{22} = 0.060$

Among other covariates presented in Appendix J, we summarize selected results that are relevant to policy. First, we find opposite roles of chronological age and birth cohorts. For instance, females tend to smoke more with age, which may relate to their lifecycle. Married women may abstain from smoking at childbearing age and (re)consider smoking after finishing fertility decisions. On the other hand, the later-born show a higher prevalence of smoking. The gradual change in social perception of female smoking could be one of the reasons for this tendency. The experience of married men is the opposite. They tend to smoke less with age. The later-born cohorts show a lower prevalence of smoking. This finding may be a result of the anti-tobacco campaign initiated in the late 1980s or the active governmental regulations from the National Health Promotion Act of 1995 (Park et al., 2014).

Secondary or higher education as well as household income are negatively correlated with a propensity for smoking in men. For women, only university attendance plays a significant role in reducing their tendency to smoke. Higher income is actually positively correlated with their smoking status. The relationship between having children and smoking status differs greatly by gender as well as by age group. Considering a large volume of literature on intergenerational transmission of smoking behavior, a positive correlation between female smoking and having children of the age of 13-18 calls for further investigation on necessary policy measures.

7.3 Drinking

As shown in Table 7, the correlation between θ_i and θ_j is strongly positive (0.676) in terms of alcohol consumption. This finding implies positive assortative mating over drinking preference. In addition, a positive and significant ρ_ϵ (0.293) indicates that common transitory shocks within a partnership may induce both partners to make similar decisions regarding alcohol intake. Based on intercorrelated unobserved characteristics, we reason that the bivariate model is a better framework for explaining both spouses' choices in drinking behavior.

Similarly to the above investigated lifestyle, from a bivariate model, we find a significant positive path dependency and spousal peer effect. The magnitude of the path dependency is relatively higher among males, which indicates their stronger addictive tendency. Furthermore, we observe that people tend to reduce alcohol consumption once they experience deterioration in their own health condition. Nevertheless, they exhibit the opposite behavior if their spouse's health is worsened, which provides counter evidence of social learning. One of the possible explanations is the increased level of stress from care-giving activity (Christakis and Allison, 2006), which can lead to more alcohol consumption.

The positive coefficient of IMR indicates that women who maintain a stable partnership are more likely to enjoy drinking or vice versa. On the other hand, the coefficient is negative for males. This gender heterogeneity may stem from different intensity of alcohol intake between males and females. That is, if males are more likely to drink heavily, their drinking behavior can cause discord within the family as well as marital dissolution, either directly or indirectly.

Table 7: The effect of individual and spousal past behavior on alcohol consumption

	Univariate				Bivariate			
	Wife		Husband		Wife		Husband	
$Y_{i,t-1}$	0.391**	(0.027)	0.733**	(0.029)	0.396**	(0.024)	0.731**	(0.029)
$Y_{i,1}$	0.119	(0.179)	2.739**	(0.046)	0.119	(0.166)	2.652**	(0.049)
$Y_{j,t-1}$	0.180**	(0.019)	0.147**	(0.014)	0.135**	(0.018)	0.121**	(0.015)
$Y_{j,1}$					-0.474**	(0.029)	0.119	(0.166)
$\triangle H_{i,t}$	-0.168**	(0.037)	0.043+	(0.037)	-0.167**	(0.023)	-0.189**	(0.027)
$\triangle H_{j,t}$	0.043+	(0.026)	-0.168**	(0.037)	0.048*	(0.020)	0.123**	(0.020)
IMR	0.650**	(0.084)	0.650**	(0.084)	0.656**	(0.050)	-0.335**	(0.037)
θ_1	0.130**	(0.037)	0.834**	(0.039)	-0.394**	(0.024)	0.807**	(0.040)
θ_2	-0.940**	(0.048)	-0.417**	(0.030)	0.675**	(0.023)	-0.444**	(0.032)
π_1	0.424		0.699		πs are presented in Table 8.			
π_2	0.576		0.301		$Corr(\tilde{\theta}_i, \tilde{\theta}_j)$=0.676			
ρ_ϵ					0.293** (0.017)			

Significance level:+p<0.10, * p<0.05, ** p<0.01

According to Table 8, 35.6% of couples are composed of a wife and a husband with positive intercepts, whilst 23.7% have negative intercepts. Couples of the former type are relatively more prone to drink compared to their counterparts of the latter type. For the rest, spousal unobserved heterogeneity diverges. Only 6.5% of partnerships consist of a wife who is more inclined to drink alcohol and a husband who is less so.

Table 8: Probability of each of the pairs of unobserved heterogeneity in the bivariate model

	θ_{H1} = 0.807**	θ_{H2} = -0.444**
θ_{W1} = -0.394**	$\pi_{11} = 0.342$	$\pi_{12} = 0.237$
θ_{W2} = 0.675**	$\pi_{21} = 0.356$	$\pi_{22} = 0.065$

Roles of other covariates based on the final model are presented in Appendix K. Age, education and religion are negatively correlated with the probability of drinking. For males, there are more abstainers among later birth cohorts. Presence of a child below the age of 7 is negatively correlated with female drinking status. Those who are remarried or working are more likely to drink alcohol.

8 Comparison of partial effect between gender

In Tables 9-11, we quantify the partial effect of individual and spousal past behavior at various timelines and compare gender differences. Concerning sedentary lifestyle (Table 9), first of all, we observe a slightly stronger path-dependency among males (0.137 vs. 0.089 percentage points). Quantitatively, the positive spousal peer effect seems equivalently important for both wives and husbands. If a spouse was physically inactive, the probability of being currently sedentary increases by 0.04-0.05 percentage points.

Nevertheless, the magnitude of the partial effects of individual and spousal past behavior are minimal at all t. This result is consistent with Kano (2008)'s finding on the obesity of American couples. The author finds that an individual's own obesity in the previous year tends to increase the probability of being obese by 2 percentage points for both males and females controlling for observed characteristics and unobserved heterogeneity. The spousal past obesity has a similar ALR with respect to males. The spousal status plays an insignificant role in wives' weights. He concludes that contributions of own and spousal lagged obesity are limited, and he suggests shared "environments" and "lifestyles" as well as "assortative mating in the marriage market" as alternative explanations for increasingly obese populations in the U.S.. Our results show that the role of the second factor may be minor. Instead, strong ρ_ϵ and $Corr(\theta_w, \theta_h)$ reported in Table 3 strengthens other explanations.

Table 9: Partial effect of own and spousal past behavior on current sedentary lifestyle

	Wife's exercising				Husband's exercising			
	Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)		Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)	
ALR	0.089**	(0.006)	0.046**	(0.003)	0.137**	(0.009)	0.040**	(0.003)
$ALRS(1)$	0.065**	(0.005)	0.032**	(0.003)	0.100**	(0.007)	0.028**	(0.003)
$ALRS(2)$	0.049**	(0.005)	0.024**	(0.003)	0.075**	(0.007)	0.020**	(0.003)
$ALRS(3)$	0.038**	(0.005)	0.018**	(0.003)	0.058**	(0.008)	0.015**	(0.003)
$ALRS(4)$	0.030**	(0.005)	0.014**	(0.003)	0.046**	(0.007)	0.011**	(0.003)
$ALRLR$	0.359**	(0.049)	0.172**	(0.021)	0.512**	(0.046)	0.129**	(0.011)

Significance level:+p<0.10, * p<0.05, ** p<0.01

Regarding smoking (Table 10), males show a relatively stronger path dependency compared to their spouses. In addition, for males, own lagged behavior is still more influential than spousal smoking status in the past. ALR of own behavior is 0.339 percentage point, which accumulates to 1 percentage point in the long run. That of spousal behavior is 0.059 percentage point in the short run and 0.134 percentage point in the long run. This magnitude is much smaller than what Mcgeary (2015) find from the American elderly couples, which is 3 percentage point both for females and males. However, her univariate fixed effect model differs from our approach that additionally considers correlated heterogeneity between couples. For females, we find an insignificant partial effect of own lagged smoking at all t, meaning that their addiction is not as problematic for males. Furthermore, their current smoking is independent of spousal participation in smoking. Synthesizing our findings, it can be suggested that the male population should be prioritized as a target for anti-smoking policies due to their more severe addiction.

Table 10: Partial effect of own and spousal past behavior on current smoking

	Wife's smoking				Husband's smoking			
	Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)		Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)	
ALR	0.124	(0.820)	-0.004	(0.024)	0.339**	(0.012)	0.059**	(0.004)
$ALRS(1)$	0.040	(0.536)	0.000	(0.006)	0.234**	(0.013)	0.032**	(0.003)
$ALRS(2)$	0.018	(0.371)	0.000	(0.003)	0.168**	(0.014)	0.020**	(0.002)
$ALRS(3)$	0.009	(0.273)	0.000	(0.002)	0.124**	(0.014)	0.014**	(0.002)
$ALRS(4)$	0.005	(0.210)	0.000	(0.001)	0.094**	(0.013)	0.011**	(0.002)
$ALRLR$	0.085	(1.018)	-0.001	(0.015)	1.039**	(0.059)	0.134**	(0.013)

Significance level:+p<0.10, * p<0.05, ** p<0.01

With respect to drinking (Table 11), we still observe a slightly stronger path dependency among males compared to their spouses, which leads to a 0.233 higher probability to continue drinking. In the short run, spousal past drinking habits are almost equivalently important for both wives and husbands. However, in the long run, the gender gap diverges to 0.034 percentage point with respect to female drinking and 0.140 percentage point for males. For the same reason applied to anti-smoking policies, it is suggested that it may be more effective if the male population is prioritized in alcohol policies. To a limited extent, females may also benefit though intra-household spillover effects.

Table 11: Partial effect of own and spousal past behavior on current alcohol consumption

	Wife's drinking				Husband's drinking			
	Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)		Own lag ($Y_{i,t-1}$)		Spousal lag ($Y_{j,t-1}$)	
ALR	0.130**	(0.009)	0.042**	(0.005)	0.233**	(0.016)	0.033**	(0.003)
$ALRS(1)$	0.059**	(0.009)	0.016**	(0.003)	0.178**	(0.013)	0.023**	(0.003)
$ALRS(2)$	0.030**	(0.007)	0.008**	(0.002)	0.140**	(0.012)	0.017**	(0.002)
$ALRS(3)$	0.017**	(0.006)	0.004*	(0.002)	0.113**	(0.012)	0.014**	(0.002)
$ALRS(4)$	0.010*	(0.004)	0.002+	(0.001)	0.093**	(0.012)	0.011**	(0.002)
$ALRLR$	0.132**	(0.017)	0.034**	(0.006)	1.145**	(0.136)	0.140**	(0.016)

Significance level:+p<0.10, * p<0.05, ** p<0.01

9 Conclusion

We investigate spousal role in the formation of health-related lifestyles such as non-exercising, smoking and drinking status, and we compare differences between gender. To control common environment and correlated unobserved heterogeneity between partners, we employ a bivariate dynamic probit model using rich longitudinal data from the Korean Labor & Income Panel Study (KLIPS). Our balanced sample contains 1,765 married couples who participated in the survey between 2005 and 2014 ($T = 10$). Our model jointly estimates a wife and her husband's behavior by letting unexplained components of each spousal behavior be correlated with each other's. For time-varying idiosyncratic shocks, we assume a bivariate normal distribution. For a time-invariant element, namely individual-specific unobserved heterogeneity, we assume a joint discrete distribution. Based on these assumptions, we demonstrate the importance of a shared environment between spouses in individual decisions on risky behavior. Our results also reveal the presence of positive assortative mating in the marriage market with respect to individual preference over exercising and drinking. Presumably due to females' limited participation in smoking, we find no evidence of assortative mating over smoking preference.

Even after controlling for common confounding factors, we observe significant roles of own and spousal past behavior with respect to most types of lifestyle, which is mostly positive. The only exception is the negative effect that a husband's smoking has on his wife's participation. This finding supports social learning. In addition to a direct spousal effect, our investigation concerns an indirect interaction through adverse health shocks. For instance, we find that married people are less likely to smoke when their spouses are ill, which indicates the presence of learning and/or altruism. Females tend to react to their husband's illness more sensitively, which is consistent with Mcgeary (2015) and Canta and Dubois (2015)'s findings.

To draw policy implications, we quantify the magnitude of path dependency and spousal influence as the average local response over various timelines and compare them between gender. However, we find only a modest effect of own and spousal past behavior (less than 2 % point). Moverover, we do not find any substantial gender difference in terms of spousal effect regarding exercising and drinking. In other words, it implies that both spouses would benefit from equivalent spillover effects from policies that promote physical activity or responsible alcohol consumption while spending time with each other. Considering males' higher path dependency regarding all types of lifestyles, nonetheless, any gender-specific policy would be more effective in targeting the male population, even though it is difficult to reduce their addictive behavior.

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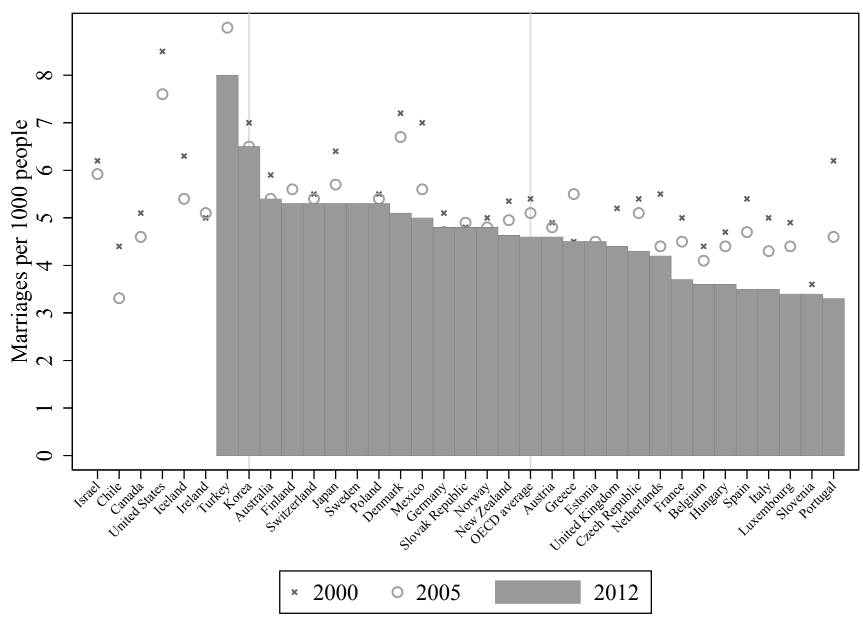
Appendices

A Perception on non-marital cohabitation in Korea (%)

	Entirely agree	Somehow agree	Somehow disagree	Entirely disagree
By year				
- 2010	5.5	35.0	32.2	27.3
- 2012	7.7	38.2	30.1	24.0
By gender				
- Male	8.8	40.3	28.8	22.2
- Female	6.6	36.2	31.4	25.8
By age				
- 13-19	11.0	46.1	29.8	13.2
- 20-29	12.9	48.3	26.8	12.1
- 30-39	11.3	50.4	25.1	13.2
- 40-49	6.3	37.3	31.3	25.1
- 50-59	4.5	28.4	32.6	34.4
- 60 or above	2.8	24.0	34.3	38.8

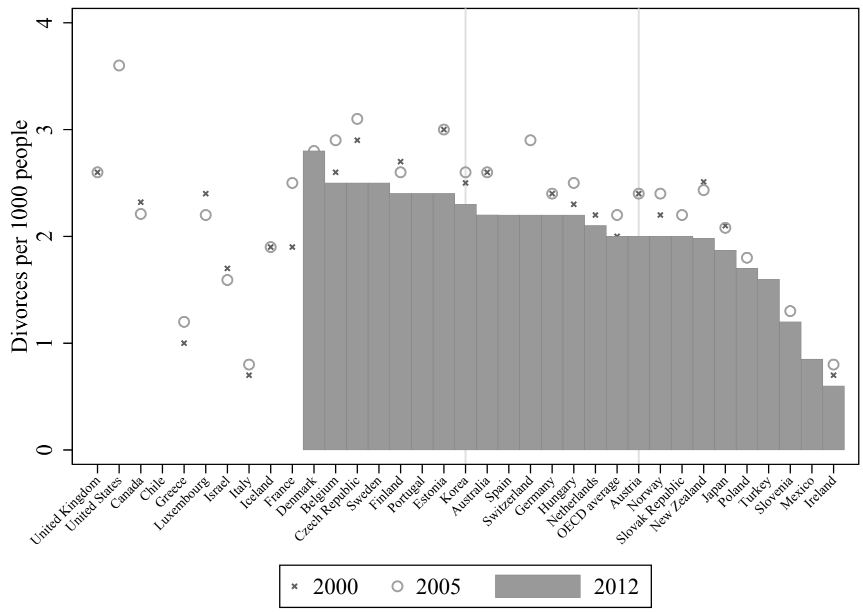
- Source: Social Survey 2012, Statistics Korea

B Crude marriage rate among the OECD member states



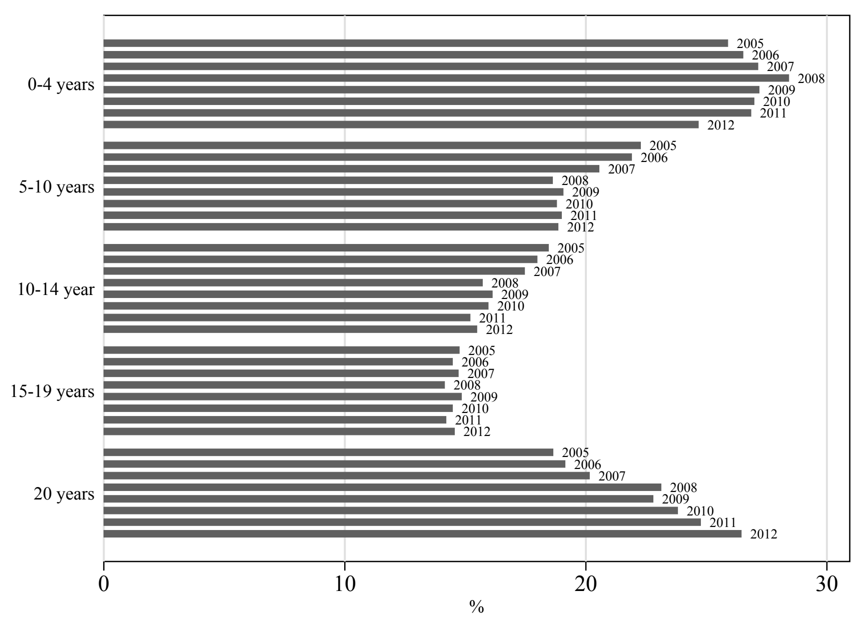
-Source: OECD.stat

C Crude divorce rate among the OECD member states



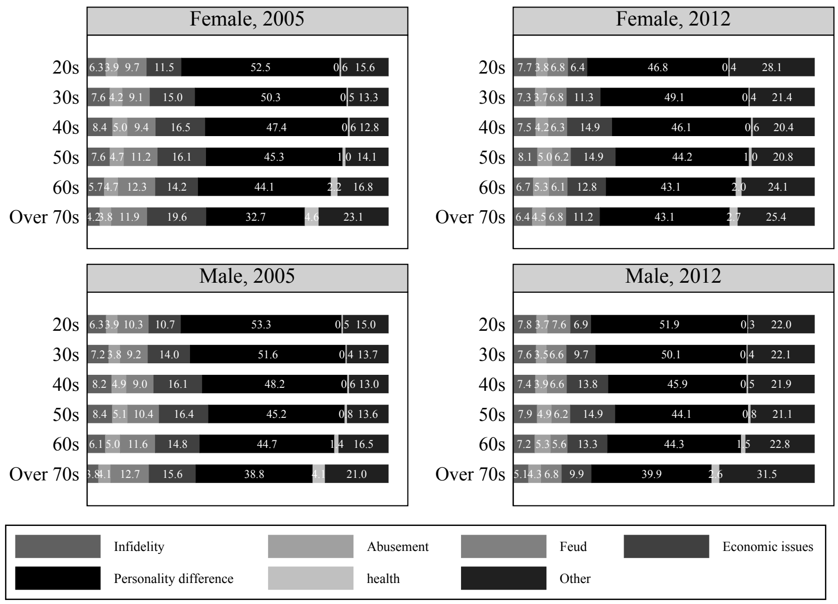
-Source: OECD.stat

D Divorce rate by marital duration between 2005-2012 in Korea



-Source: Korean Statistical Information Service

E Divorce by reason in Korea (%)



-Source: Korean Statistical Information Service

F Cross-country comparison of lifestyle of the population aged 15+

	Korea	U.S.	U.K.	Note
Daily smoking rate				aged 15+, 2013
- Male	36.2	15.6	22.0	
- Female	4.3	11.9	17.0	
Share of hazardous drinkers	(2012)	(2011)	(2011)	aged 25+
- Male with low education	30.5	12.7	18.3	
- Male with high education	15.4	8.0	23.4	
- Female with low education	4.6	3.5	8.9	
- Female with high education	2.3	4.3	20.0	
Daily time spent on sports (mins)	(2009)	(2014)	(2005)	aged 15-64
- Male	31	24	24	
- Female	23	13	19	

- Source: OECD (2015; 2016)

G Summary statistics

	Wife Mean (SD)	Husband Mean (SD)
Sedentariness	0.700 (0.458)	0.651 (0.477)
Smoking	0.007 (0.083)	0.458 (0.498)
Drinking	0.363 (0.481)	0.760 (0.427)
Health shock	0.129 (0.335)	0.113 (0.317)
Age	51.168 (11.863)	54.482 (12.379)
Born=1910-30s (ref.)	0.083 (0.276)	0.136 (0.343)
=1940s	0.183 (0.387)	0.231 (0.422)
=1950s	0.278 (0.448)	0.274 (0.446)
=1960s	0.282 (0.450)	0.256 (0.436)
=1970-90s	0.174 (0.379)	0.103 (0.303)
Degree=none (ref.)	0.252 (0.434)	0.138 (0.345)
=primary school	0.185 (0.388)	0.165 (0.371)
=middle school	0.371 (0.483)	0.388 (0.487)
=high school	0.081 (0.273)	0.084 (0.278)
=university	0.111 (0.314)	0.224 (0.417)
Religion=none/other (ref.)	0.408 (0.492)	0.531 (0.499)
=Buddhist	0.278 (0.448)	0.234 (0.423)
=Christian	0.314 (0.464)	0.235 (0.424)
Difficult mobility	0.072 (0.259)	0.067 (0.250)
Difficult remembering	0.030 (0.171)	0.037 (0.189)
Difficult indoor activity	0.011 (0.106)	0.015 (0.120)
Difficult outdoor activity	0.030 (0.172)	0.030 (0.170)
Difficult working	0.108 (0.311)	0.100 (0.300)
Born=Seoul (ref.)	0.084 (0.278)	0.078 (0.268)
=Gyeongsang-do	0.347 (0.476)	0.344 (0.475)
=Gyeonggi-do	0.112 (0.316)	0.116 (0.320)
=Chungcheong-do	0.167 (0.373)	0.166 (0.372)
=Jeolla-do	0.228 (0.419)	0.213 (0.409)
=elsewhere	0.061 (0.240)	0.083 (0.276)
Father's education=Secondary (vs. below)	0.241 (0.428)	0.231 (0.422)
Age at marriage	23.973 (3.355)	27.249 (3.528)
Remarried	0.015 (0.123)	0.019 (0.135)
Working status (vs. none)	0.499 (0.500)	0.780 (0.414)

	Household	
	Mean	(SD)
HH income (1,000 Won)	171.562	(182.788)
At least one child 0-3 years old	0.063	(0.244)
At least one child 4-6 years old	0.082	(0.274)
At least one child 7-12 years old	0.190	(0.392)
At least one child 13-18 years old	0.225	(0.418)
At least one child over 19 years old	0.541	(0.498)
Live=Seoul (ref.)	0.195	(0.397)
=Gyeongsang-do	0.314	(0.464)
=Gyeonggi-do	0.279	(0.449)
=Chungcheong-do	0.095	(0.294)
=Jeolla-do	0.088	(0.283)
=elsewhere	0.028	(0.164)
Observations	17,650	

H Selection into a balanced sample

	Female		Male	
	Coef.	SE	Coef.	SE
Age	0.004**	(0.001)	0.013**	(0.001)
Degree=primary school (vs.none)	0.235**	(0.028)	0.138**	(0.031)
=middle school	0.021	(0.027)	0.074*	(0.028)
=high school	-0.052	(0.036)	0.064	(0.037)
=university	-0.192**	(0.032)	-0.072+	(0.030)
At least one child 0-3 years old	-0.107**	(0.030)	-0.097*	(0.030)
At least one child 4-6 years old	-0.183**	(0.026)	-0.201**	(0.026)
At least one child 7-12 years old	-0.146**	(0.021)	-0.128**	(0.021)
At least one child 13-18 years old	0.088**	(0.023)	0.112**	(0.022)
At least one child over 19 years old	-0.018	(0.025)	-0.089**	(0.025)
Live=Gyeongsang-do (vs. Seoul)	-0.031	(0.027)	0.180**	(0.027)
=Gyeonggi-do	-0.115**	(0.024)	0.067*	(0.023)
=Chungcheong-do	0.002	(0.037)	0.242**	(0.036)
=Jeolla-do	-0.109*	(0.038)	0.144**	(0.038)
=Elsewhere	0.125	(0.064)	0.360**	(0.062)
Year=2006 (vs. 2005)	0.111**	(0.030)	0.082*	(0.031)
=2007	0.160**	(0.031)	0.131**	(0.031)
=2008	0.218**	(0.032)	0.189**	(0.032)
=2009	0.296**	(0.033)	0.264**	(0.033)
=2010	0.383**	(0.033)	0.303**	(0.033)
=2011	0.439**	(0.034)	0.353**	(0.034)
=2012	0.444**	(0.034)	0.358**	(0.034)
=2013	0.499**	(0.036)	0.410**	(0.035)
=2014	0.530**	(0.036)	0.465**	(0.036)
Health shock	-0.172**	(0.024)	-0.226**	(0.025)
Economic activity	0.040+	(0.016)	0.187**	(0.023)
Regional unemployment rate	-0.028+	(0.013)	0.033+	(0.013)
Constant	0.218+	(0.096)	-0.840**	(0.102)
Observations	30,171		29,533	

I Full result: Sedentariness

	Wife Coef. SE	Husband Coef. SE
a. Own and spousal behavior		
Own exercising at $t-1$	0.291** (0.020)	0.423** (0.022)
Own exercising at $t=0$	0.119 (0.134)	0.119 (0.134)
Spousal exercising at $t-1$	0.153** (0.021)	0.130** (0.017)
Spousal exercising at $t=0$	0.119 (0.134)	0.119 (0.134)
b. Health shock		
Own health	0.005 (0.014)	0.074** (0.018)
Spousal health	0.113** (0.016)	0.004 (0.017)
c. Inverse mils ratio	-0.137** (0.022)	0.333** (0.104)
d. Individual characteristics		
Age/100	-1.109** (0.092)	1.201** (0.100)
Born=1940s (ref.1910-30s)	-0.175** (0.024)	0.092* (0.038)
=1950s	-0.274** (0.031)	0.264** (0.039)
=1960s	-0.432** (0.033)	0.256** (0.062)
=1970-90s	-0.409** (0.044)	0.330** (0.071)
Degree=primary school (vs.none)	-0.378** (0.031)	-0.014 (0.027)
=middle school	-0.479** (0.027)	-0.277** (0.032)
=high school	-0.486** (0.050)	-0.369** (0.047)
=university	-0.663** (0.045)	-0.652** (0.038)
Religion=Buddhist (vs. none/other)	-0.191** (0.035)	-0.006 (0.017)
=Christian	-0.098** (0.024)	-0.066** (0.019)
Difficult mobility (vs. none)	-0.034 (0.055)	-0.131** (0.028)
Difficult remembering (vs. none)	0.072** (0.028)	-0.084+ (0.049)
Difficult indoor activity (vs. none)	0.035 (0.042)	0.092 (0.058)
Difficult outdoor activity (vs. none)	0.161** (0.047)	0.330** (0.066)
Difficult working (vs. none)	-0.043 (0.034)	0.071* (0.032)
Born=Gyeongsang-do (vs. Seoul)	-0.021 (0.024)	-0.173** (0.044)
=Gyeonggi-do	-0.077** (0.025)	-0.177** (0.036)
=Chungcheong-do	-0.074** (0.019)	-0.183** (0.034)
=Jeolla-do	-0.120** (0.025)	-0.094** (0.019)
=Elsewhere	-0.030 (0.035)	-0.045 (0.032)
Father's education=Secondary (vs. below)	0.093** (0.017)	-0.043 (0.027)
Age at marriage/100	1.081** (0.143)	0.378** (0.058)
Remarried	0.250* (0.100)	0.240** (0.071)
Working status (vs. none)	0.377** (0.025)	0.411** (0.023)

Full result is continued here.

	Wife		Husband	
	Coef.	SE	Coef.	SE
e. Average individual characteristics				
Difficult $\overline{mobility}$	0.258**	(0.047)	0.573**	(0.070)
Difficult $\overline{remembering}$	-0.715**	(0.104)	-0.244*	(0.119)
Difficult $\overline{indoor}$ activity	-0.284**	(0.086)	0.197*	(0.095)
Difficult $\overline{ourdoor}$ activity	0.738**	(0.098)	-0.143**	(0.047)
Difficult $\overline{working}$	0.035	(0.048)	-0.193**	(0.049)
Religion=$\overline{Buddhist}$	-0.056+	(0.030)	-0.170**	(0.018)
=$\overline{Christian}$	-0.021	(0.036)	-0.152**	(0.024)
$\overline{deterioration}$ of own health	-0.063	(0.038)	0.189**	(0.046)
$\overline{working}$ status	0.314**	(0.027)	0.252**	(0.030)
f. Household characteristics				
HH income/1,000 won	-0.029	(0.027)	-0.137**	(0.051)
At least one child 0-3 years old	0.562**	(0.100)	0.206**	(0.041)
At least one child 4-6 years old	0.122**	(0.028)	0.107**	(0.030)
At least one child 7-12 years old	0.029	(0.026)	0.088**	(0.024)
At least one child 13-18 years old	-0.013	(0.019)	0.045**	(0.014)
At least one child over 19 years old	0.041**	(0.014)	0.049**	(0.012)
Live=Gyeongsang-do (vs. Seoul)	0.345**	(0.030)	0.411**	(0.028)
=Gyeonggi-do	0.131**	(0.023)	0.164**	(0.020)
=Chungcheong-do	0.202**	(0.045)	0.222**	(0.040)
=Jeolla-do	0.003	(0.024)	-0.180**	(0.031)
=Elsewhere	0.106*	(0.042)	0.223**	(0.063)
g. Average household characteristics				
$\overline{HHincome}$/1000	-0.566**	(0.102)	-0.572**	(0.083)
At least $\overline{one}$ child 0-3 years old	0.240**	(0.092)	-0.012	(0.040)
At least $\overline{one}$ child 4-6 years old	0.030	(0.062)	0.107+	(0.056)
At least $\overline{one}$ child 7-12 years old	0.064**	(0.019)	0.013	(0.019)
At least $\overline{one}$ child 13-18 years old	0.059*	(0.026)	-0.017	(0.023)
At least $\overline{one}$ child over 19 years old	0.059**	(0.014)	-0.020	(0.019)
h. Year				
2006 (vs. 2014)	-0.042*	(0.019)	-0.086**	(0.016)
2007	-0.084**	(0.013)	-0.036**	(0.012)
2008	0.053*	(0.027)	0.110**	(0.018)
2009	-0.215**	(0.030)	-0.038**	(0.012)
2010	0.020+	(0.011)	0.103**	(0.017)
2011	0.002	(0.029)	0.109**	(0.023)
2012	-0.061**	(0.013)	0.011	(0.020)
2013	-0.007	(0.017)	0.074**	(0.020)

J Full result: Smoking

	Wife Coef. SE	Husband Coef. SE
a. Own and spousal behavior		
Own smoking at $t-1$	1.025** (0.107)	0.966 (0.021)
Own smoking at $t=0$	0.191 (0.177)	3.679 (0.040)
Spousal smoking at $t-1$	-0.054** (0.004)	0.190 (0.039)
Spousal smoking at $t=0$	-5.790** (0.093)	0.191 (0.177)
b. Health shock		
Own health	-0.128** (0.007)	0.052** (0.006)
Spousal health	-0.296** (0.012)	-0.008 (0.005)
c. Inverse mils ratio	1.695** (0.046)	-0.785** (0.022)
d. Individual characteristics		
Age/100	3.254** (0.159)	-5.664** (0.066)
Born=1940s (ref.1910-30s)	0.360** (0.024)	-0.211** (0.012)
=1950s	0.917** (0.042)	-0.384** (0.015)
=1960s	0.282** (0.023)	-0.746** (0.031)
=1970-90s	0.669** (0.059)	-0.692** (0.045)
Degree=primary school (vs.none)	0.518** (0.033)	0.025** (0.006)
=middle school	0.247** (0.009)	-0.121** (0.007)
=high school	-4.935 (15.802)	-0.155** (0.016)
=university	-0.582** (0.060)	-0.316** (0.017)
Religion=Buddhist (vs. none/other)	-0.155** (0.016)	0.114** (0.007)
=Christian	-0.895** (0.066)	-0.254** (0.014)
Difficult mobility (vs. none)	0.102** (0.006)	-0.023+ (0.013)
Difficult remembering (vs. none)	-0.074** (0.016)	0.034* (0.015)
Difficult indoor activity (vs. none)	1.741** (0.149)	-0.350** (0.041)
Difficult outdoor activity (vs. none)	-0.086** (0.027)	-0.169** (0.013)
Difficult working (vs. none)	-0.027 (0.021)	-0.045** (0.007)
Born=Gyeongsang-do (vs. Seoul)	-0.045** (0.008)	-0.240** (0.018)
=Gyeonggi-do	-0.495** (0.040)	-0.334** (0.021)
=Chungcheong-do	-0.626** (0.051)	-0.395** (0.021)
=Jeolla-do	0.222** (0.024)	-0.257** (0.014)
=Elsewhere	-0.306** (0.055)	-0.144** (0.010)
Father's education=Secondary (vs. below)	0.341** (0.037)	0.066** (0.006)
Age at marriage/100	1.874** (0.134)	-0.179** (0.005)
Remarried	0.376** (0.067)	-0.011 (0.023)
Working status (vs. none)	-0.198** (0.010)	-0.021** (0.003)

Full result is continued here.

	Wife Coef.	SE	Husband Coef.	SE
e. Average individual characteristics				
Difficult $\overline{mobility}$	0.839**	(0.040)	0.462**	(0.026)
Difficult $\overline{remembering}$	-0.865**	(0.070)	-0.257**	(0.020)
Difficult $\overline{indoor}$ activity	-3.266**	(0.579)	-0.770**	(0.099)
Difficult $\overline{ourdoor}$ activity	-1.267**	(0.184)	0.464**	(0.032)
Difficult $\overline{working}$	-0.549**	(0.060)	-0.586**	(0.027)
Religion=$\overline{Buddhist}$	-0.539**	(0.029)	-0.341**	(0.016)
=$\overline{Christian}$	0.203**	(0.008)	-0.290**	(0.012)
$\overline{deterioration}$ of own health	1.626**	(0.064)	0.203**	(0.009)
$\overline{working}$ status	0.660**	(0.036)	-0.178**	(0.007)
f. Household characteristics				
HH income/1,000 won	0.267**	(0.027)	-0.106**	(0.013)
At least one child 0-3 years old	0.684**	(0.062)	0.019**	(0.007)
At least one child 4-6 years old	-0.280**	(0.021)	0.114**	(0.024)
At least one child 7-12 years old	0.558**	(0.031)	0.014+	(0.008)
At least one child 13-18 years old	0.284**	(0.022)	0.022**	(0.008)
At least one child over 19 years old	-0.110**	(0.007)	-0.023**	(0.005)
Live=Gyeongsang-do (vs. Seoul)	-0.087**	(0.008)	-0.105**	(0.010)
=Gyeonggi-do	0.041**	(0.007)	0.055**	(0.005)
=Chungcheong-do	0.135**	(0.009)	0.005	(0.017)
=Jeolla-do	-1.514**	(0.099)	-0.236**	(0.018)
=Elsewhere	0.792**	(0.113)	0.018	(0.019)
g. Average household characteristics				
$\overline{HHincome}$/1000	-4.192	(6.693)	0.095**	(0.018)
At least $\overline{one}$ child 0-3 years old	-0.923**	(0.112)	-0.282**	(0.043)
At least $\overline{one}$ child 4-6 years old	1.520**	(0.191)	0.253**	(0.027)
At least $\overline{one}$ child 7-12 years old	-1.135**	(0.086)	0.059**	(0.006)
At least $\overline{one}$ child 13-18 years old	0.611**	(0.051)	0.240**	(0.012)
At least $\overline{one}$ child over 19 years old	-0.375**	(0.014)	-0.201**	(0.010)
h. Year				
2006 (vs. 2014)	0.257**	(0.010)	0.049**	(0.006)
2007	0.393**	(0.026)	-0.014**	(0.004)
2008	-0.072**	(0.003)	0.043**	(0.004)
2009	0.171**	(0.014)	-0.004	(0.003)
2010	0.116**	(0.012)	0.013**	(0.004)
2011	0.190**	(0.007)	-0.014+	(0.009)
2012	0.356**	(0.011)	0.044**	(0.005)
2013	0.062**	(0.005)	-0.042**	(0.004)

K Full result: Alcohol consumption

	Wife Coef. SE	Husband Coef. SE
a. Own and spousal behavior		
Own drinking at $t-1$	0.396** (0.024)	0.731** (0.029)
Own drinking at $t=1$	0.119 (0.166)	2.652** (0.049)
Spousal drinking at $t-1$	0.135** (0.018)	0.121** (0.015)
Spousal drinking at $t=1$	-0.474** (0.029)	0.119 (0.166)
b. Health shock		
Own health	-0.167** (0.023)	-0.189** (0.027)
Spousal health	0.048* (0.020)	0.123** (0.020)
c. Inverse mils ratio	0.656** (0.050)	-0.335** (0.037)
d. Individual characteristics		
Age/100	-1.401** (0.048)	-3.506** (0.109)
Born=1940s (ref.1910-30s)	-0.047* (0.022)	-0.254** (0.029)
=1950s	0.222** (0.025)	-0.434** (0.033)
=1960s	0.402** (0.028)	-0.430** (0.047)
=1970-90s	0.505** (0.039)	-0.532** (0.080)
Degree=primary school (vs.none)	0.109** (0.019)	-0.151** (0.024)
=middle school	0.146** (0.023)	-0.184** (0.022)
=high school	-0.079+ (0.040)	-0.140** (0.037)
=university	-0.025 (0.020)	-0.135** (0.023)
Religion=Buddhist (vs. none/other)	-0.041* (0.016)	-0.016 (0.020)
=Christian	-0.050** (0.016)	-0.208** (0.023)
Difficult mobility (vs. none)	0.016 (0.023)	-0.111** (0.026)
Difficult remembering (vs. none)	0.189** (0.042)	0.089** (0.025)
Difficult indoor activity (vs. none)	-0.043 (0.051)	-0.267** (0.068)
Difficult outdoor activity (vs. none)	-0.059+ (0.033)	-0.221** (0.045)
Difficult working (vs. none)	-0.174** (0.024)	-0.154** (0.024)
Born=Gyeongsang-do (vs. Seoul)	0.037* (0.017)	-0.088** (0.020)
=Gyeonggi-do	-0.015 (0.028)	-0.001 (0.023)
=Chungcheong-do	0.085** (0.020)	-0.124** (0.027)
=Jeolla-do	0.040* (0.019)	0.013 (0.018)
=Elsewhere	0.103** (0.030)	-0.047+ (0.027)
Father's education=Secondary (vs. below)	-0.002 (0.018)	0.041+ (0.025)
Age at marriage/100	-0.882** (0.107)	0.772** (0.115)
Remarried	0.327** (0.089)	0.241** (0.088)
Working status (vs. none)	0.180** (0.017)	0.120** (0.014)

Full result is continued here.

	Wife		Husband	
	Coef.	SE	Coef.	SE
e. Average individual characteristics				
Difficult $\overline{mobility}$	-0.168**	(0.027)	0.264**	(0.055)
Difficult $\overline{remembering}$	0.196**	(0.052)	-0.627**	(0.104)
Difficult $\overline{indoor}$ activity	-0.118**	(0.043)	-0.103**	(0.036)
Difficult $\overline{ourdoor}$ activity	-0.481**	(0.099)	-0.172**	(0.046)
Difficult $\overline{working}$	0.204**	(0.043)	-0.181**	(0.025)
Religion=$\overline{Buddhist}$	0.060**	(0.014)	-0.169**	(0.023)
=$\overline{Christian}$	-0.435**	(0.032)	-0.477**	(0.037)
$\overline{deterioration}$ of own health	-0.056**	(0.010)	-0.166**	(0.032)
$\overline{working}$ status	0.159**	(0.022)	-0.024*	(0.012)
f. Household characteristics				
HH income/1,000 won	0.037	(0.032)	0.027	(0.040)
At least one child 0-3 years old	-0.139**	(0.039)	0.034	(0.028)
At least one child 4-6 years old	-0.133**	(0.025)	0.122**	(0.025)
At least one child 7-12 years old	0.004	(0.019)	0.027	(0.018)
At least one child 13-18 years old	0.137**	(0.015)	-0.044*	(0.019)
At least one child over 19 years old	0.064**	(0.015)	0.039**	(0.014)
Live=Gyeongsang-do (vs. Seoul)	-0.026	(0.019)	-0.142**	(0.023)
=Gyeonggi-do	-0.041**	(0.016)	-0.024	(0.016)
=Chungcheong-do	-0.056*	(0.026)	-0.015	(0.031)
=Jeolla-do	-0.127**	(0.029)	-0.326**	(0.045)
=Elsewhere	-0.064	(0.041)	-0.158**	(0.052)
g. Average household characteristics				
$\overline{HHincome}/1000$	0.134**	(0.052)	0.553**	(0.106)
At least $\overline{one}$ child 0-3 years old	0.014	(0.040)	0.157**	(0.060)
At least $\overline{one}$ child 4-6 years old	0.013	(0.044)	-0.513**	(0.065)
At least $\overline{one}$ child 7-12 years old	-0.086**	(0.019)	-0.045*	(0.022)
At least $\overline{one}$ child 13-18 years old	-0.167**	(0.017)	-0.033*	(0.017)
At least $\overline{one}$ child over 19 years old	-0.052**	(0.015)	-0.056**	(0.020)
h. Year				
2006 (vs. 2014)	0.008	(0.017)	0.001	(0.021)
2007	0.061**	(0.013)	-0.055**	(0.014)
2008	0.014	(0.016)	0.068**	(0.012)
2009	-0.016	(0.012)	0.017	(0.011)
2010	0.050**	(0.014)	0.092**	(0.016)
2011	0.075**	(0.017)	0.053**	(0.013)
2012	0.061**	(0.014)	0.057**	(0.011)
2013	0.008	(0.018)	0.024+	(0.013)